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Preliminary Assessment of the Potential for Inducing Stormwater Infiltration in Cook County, Illinois

Open-File Report 2009–1212

U.S. Department of the Interior
U.S. Geological Survey

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By William S. Morrow and Jennifer B. Sharpe

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Conversion Factors and Abbreviations

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	.3048	meter (m)
mile (mi)	1.609	kilometer (km)
meter (m)	3.281	foot (ft)
	Area	
acre	4,047	square meter (m^2)
acre	.004047	square kilometer (km^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	.003785	cubic meter (m^3)
cubic foot (ft^3)	.02832	cubic meter (m^3)
	Flow rate	
foot per second (ft/s)	.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	.02832	cubic meter per second (m^3/s)

Miscellaneous Abbreviations

Cal-Sag	Calumet Sag
CERCLA	Comprehensive Environmental Response, Contamination and Liability Act
GIS	Geographic Information System
ICN	Illinois Climate Network
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
LUST	Leaking Underground Storage Tank
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NED	National Elevation Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NWI	National Wetlands Inventory
NWIS	National Water Information System
RCRA	Resource Conservation and Recovery Act
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Survey Geographic Database
TARP	Tunnel and Reservoir Project
USEPA	U.S. Environmental Protection Agency

Preliminary Assessment of the Potential for Inducing Stormwater Infiltration in Cook County, Illinois

By William S. Morrow and Jennifer B. Sharpe

Abstract

The Metropolitan Water Reclamation District of Greater Chicago is responsible for all of the regional stormwater management for Cook County in northeastern Illinois, one of the largest urban areas in the United States. Continuing urban expansion in this area has increased stormwater runoff and combined sewer overflows and likely decreased groundwater recharge. Passive induced-infiltration structures may help reduce stormflow problems and increase infiltration. These structures must be properly located to function effectively. Using hydrogeologic and land cover and use characteristics, maps of Cook County were developed indicating areas having the most potential for inducing stormwater infiltration. This assessment is preliminary because the scale of the mapping only gives a general indication of potential infiltration areas and is not suitable for site-specific investigations. In Cook County, 76,080 of 612,636 acres (12.4 percent) were determined to have the greatest potential for passive induced-infiltration-structure locations. Of these 76,080 acres, 8,650 are within the Lake Michigan surface watershed, with the remaining 67,430 acres within the Illinois River surface watershed. If all the annual rainfall on the 8,650 acres infiltrated and flowed to Lake Michigan, the resulting groundwater flux would be about 33 cubic feet per second (ft^3/s).

Introduction

Artificial or induced recharge is the addition of water, usually surplus surface water, to groundwater storage by other than natural means. Induced recharge historically has been used for increasing potable groundwater supply, diversion and infiltration of reclaimed wastewater, and diversion and infiltration of excess stormwater runoff, through passive (infiltration-basin style structures) and active (injection-well structures) methods.

Continuing urban expansion has resulted in an increase in stormwater runoff and combined sewer overflow events as well as a likely decrease in groundwater recharge in Cook County, Illinois (Allen and Bejcek, 1979). One method of potentially reducing flooding, reducing the size and frequency of combined storm-sewer overflows, and partially restoring depleted groundwater in the area is to divert stormwater runoff to passive induced-infiltration structures, which could range from smaller rain-garden structures to full-size infiltration basins. This also could potentially increase groundwater recharge in the Illinois River and Lake Michigan watersheds (fig. 1).

The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) is responsible for stormwater management in Cook County. Presently (2009), the MWRDGC is drafting a Watershed Management Ordinance, which may include requirements for volume control as a component of site stormwater-detention regulations.

One method by which a volume-control requirement could be met is through construction of passive induced-infiltration structures. Many standards and recommendations for infiltration-basin design requirements have been developed throughout the Nation. In Illinois, the adjoining counties of McHenry and DuPage have regulations and guidance regarding infiltration-basin design that include assessing suitability of hydrogeologic and land cover and use characteristics.

The U.S. Geological Survey (USGS), in cooperation with the MWRDGC, conducted a preliminary examination of the general potential for the application of induced passive infiltration in Cook County by determining what areas under MWRDGC or Cook County jurisdiction were suitable for passive induced-infiltration structures, based on hydrogeologic and land cover and use characteristics.

Purpose and Scope

This report summarizes the process used to delineate areas within Cook County that have hydrogeologic and land cover characteristics generally considered favorable or limiting for passive induced infiltration. This assessment is preliminary because the scale of the mapping only gives a general indication of potential infiltration areas and is not suitable for site-specific investigations. Field confirmation of a) the hydrogeology including nature of subsurface deposits, wetland areas, stream interactions, and depth to saturation, b) the orientation of sewer systems and drainage tiles, c) other infrastructure such as buildings with basements, supply wells, dewatering activities, and d) the nature of legacy contamination would be components of a detailed assessment of site suitability. The report also contains a preliminary assessment of what portion of those potential areas may contribute groundwater flow toward Lake Michigan.

Water-quality issues are not in the scope of this report, but will need to be addressed prior to construction of any passive induced-infiltration structure. However, the purpose of a passive induced-infiltration structure in Cook County would be for reducing stormwater runoff, and not to replenish an aquifer used for a drinking-water source, because Cook County primarily uses Lake Michigan for a drinking-water source.

Study Area

Cook County, Illinois, includes Chicago and 129 smaller municipalities and is one of the largest urban areas in the United States. The MWRDGC is responsible for wastewater treatment for approximately 91 percent of Cook County exclusive of smaller isolated land areas that do not discharge directly into MWRDGC facilities. There are seven operating water-reclamation plants including the Stickney Water Reclamation Plant, the second largest in the world (fig. 1). The MWRDGC is responsible for stormwater management for the entire 946 mi^2 area of Cook County.

Quaternary glacial and alluvial deposits cover most of Cook County, with thicknesses from zero to approaching 300 ft in some areas (Leetaru and others, 2004). These unconsolidated deposits generally overlie Silurian bedrock. (Arnold and Friedel, 2000; Bretz, 1955; Willman and others, 1975).

Cook County lies in the Great Lakes physiographic section. Approximately half of Cook County is within the Chicago Lake Plain subsection; the other half is within the Wheaton Morainal Plain/Valparaiso Morainal subsection (Fenneman, 1938). Notable geomorphic features include the sand deposits of the Wilmette, Rosehill, and Graceland Spits on the north side of Cook County and the moraine remnant of Blue Island near the south side of Cook County.

Five drainage basins are in Cook County: Chicago; Des Plaines; Little Calumet-Galien; Pike-Root; and Upper Fox. Major streams include the Calumet River, Chicago River, Des Plaines River, Little Calumet River, Poplar Creek, Salt Creek, Thorn Creek, Tinley Creek, and other smaller streams. Most surface water flows into the Calumet Sag (Cal-Sag) Channel and the Sanitary and Ship Canal and eventually into the Illinois River (fig. 1).

In 1900, the Main Channel of the Sanitary and Ship Canal was opened, reversing the flow of the Chicago River. This reversal diverted a substantial volume of stormwater runoff, sewage, and Lake Michigan water from the Lake Michigan Basin into the Illinois River Basin. By Supreme Court Order, the State of Illinois is allocated 3,200 ft^3/s from Lake Michigan. The lake water makes up a small portion of the water in the Chicago Waterway system, which mainly consists of treatment-plant effluent and natural sources. The Chicago Sanitary and Ship Canal and the Cal-Sag Channel converge near Lemont, Ill., and eventually pass through hydroelectric generators at Lockport, Ill. The Canal merges with the Des Plaines River near Joliet, Ill.

In 1985, the MWRDGC Tunnel and Reservoir Project (TARP) began operation. TARP is a system of underground tunnels and below-grade reservoirs designed to reduce combined sewage overflows into the Chicago area waterways by capturing the overflows and storing the water until the treatment plants have the capacity to treat and release the water into the waterways. The system currently (2009) has the capacity to temporarily store 2.3 billion gallons of combined sewage overflow. When completed, TARP will be capable of storing 17.5 billion gallons of combined sewage overflow (Jonathan Grabowy, MWRDGC, personal commun., 2009).

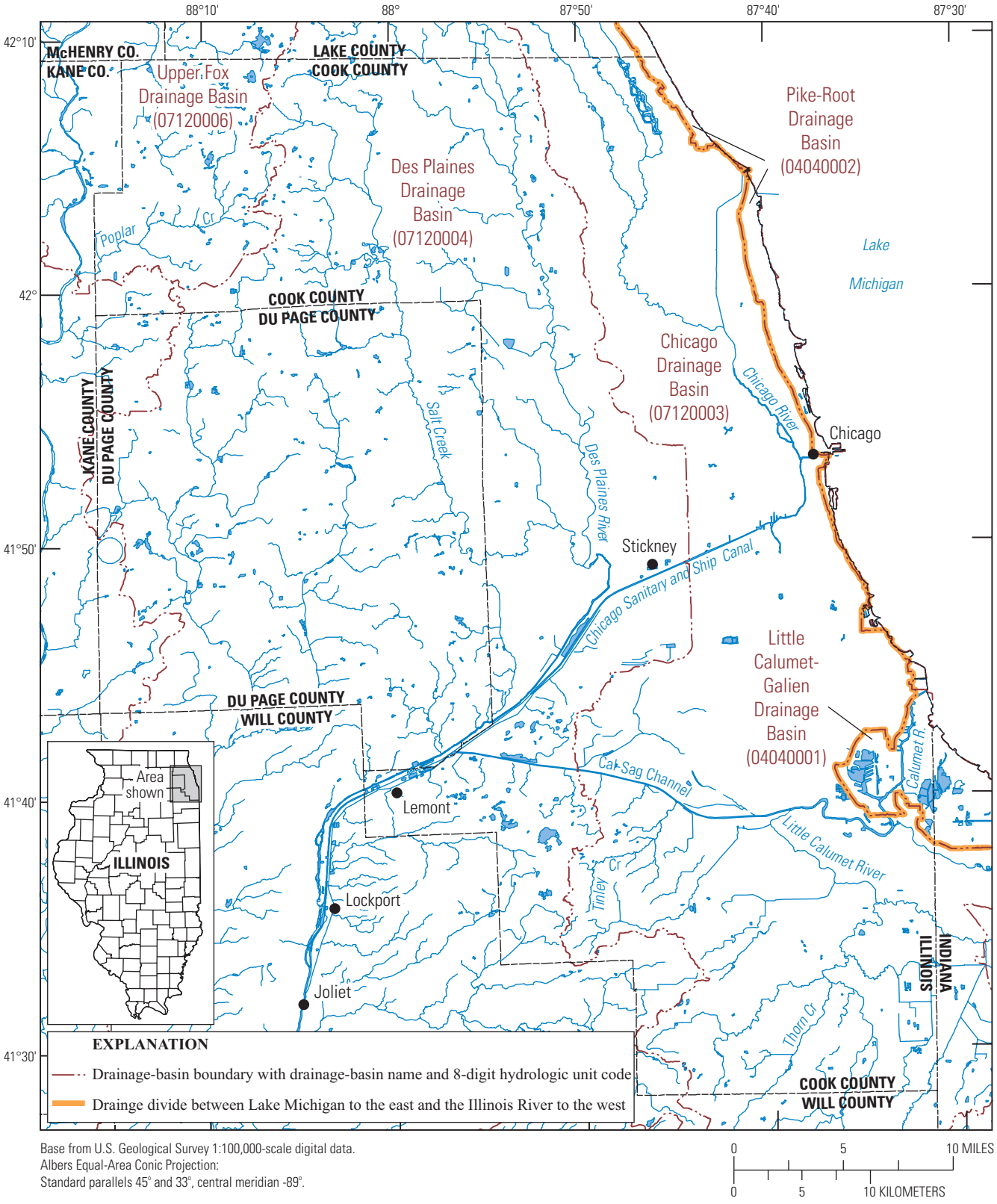

Figure 1. Drainage basins and streams in Cook County, northeastern Illinois.

Methodology

To identify areas potentially suitable for induced stormwater infiltration, hydrogeologic and land cover characteristics were evaluated. The primary considerations were hydrogeologic characteristics (especially porosity and permeability), depth from ground surface to an aquifer capable of transporting the water away from the area, and the thickness of the unsaturated zone (depth to water table) of the area.

Previous mapping studies related to potential infiltration in the study area include Berg and Kempton (1984); statewide map of potential contamination of shallow aquifers from surface and near-surface disposal of waste (Berg and others, 1984); stack-unit map of earth materials to depth of 15 m (Berg and Kempton, 1988); statewide map of potential for aquifer recharge (Keefer and Berg, 1990); aquifer-contamination potential map in the central U.S. (Soller and Berg, 1992); and model of recharge potential as affected by land use in the upper Illinois River Basin (Arnold and Friedel, 2000). Previous mapping studies of potential infiltration generally relied on arbitrarily weighted attributions to geology, soils, permeability, and depth to water table to develop maps indicating an indexed range of possible values with qualitative terms such as "low" and "high." The previous mapping studies did not take into account locations of man-made structures when determining the potential for infiltration. For this report, the delineation of areas suitable for induced infiltration were determined using a dichotomous decision process, with determining factors for infiltration either being false (deleted from the mapping area) or true (remaining in the mapping area).

Geographic Information System (GIS) geospatial data sets comprising hydrogeologic and land cover and use information for Cook County were compiled and used in this process. Geology considered favorable to infiltration was used to determine the initial potential infiltration area in Cook County. GIS spatial data sets for National Wetlands sites then were applied and unsuitable areas were removed to refine potential infiltration areas. The depth-to-saturated-zone data set was developed by kriging available water-table levels from wells and surface-water elevations. This depth-to-saturated-zone data set also was used to delete unsuitable areas and further refine potential infiltration areas. Land cover and use including infrastructure and legacy contamination was used to refine the potential infiltration area in Cook County. Characteristics that need to be considered on an individual-site basis, but are not easily defined in the county wide mapping (e.g., basements, sewer locations, and supply wells), are discussed.

Hydrogeologic Characteristics

Surficial geology is an initial consideration. Geomorphically, the surficial geology of Cook County is a heavily urbanized and altered landscape. In general, constructing suitable infiltration systems requires excavation of the initial contact layer between stormwater and the underlying permeable geologic units, either by creating a porous vegetated contact area or creating an initially highly porous contact area for the stormwater. Surficial materials in Cook County are typically not original, undisturbed soils. Therefore, original surficial geology was not considered as a determining factor in delineation.

Unconsolidated Deposits

The unconsolidated deposits underlying an infiltration structure must be sufficiently permeable to be able to accept the stormwater and be able to transport water away from the basin area, with surface water preferably entirely drained within 72 hours (U.S. Environmental Protection Agency, 1993). The data coverage from Riggs and others (1997), "Coarse Grained Materials within 50 feet of the Ground Surface in Illinois," was used to initially delineate potential induced-infiltration areas. The Riggs and others (1997) map was developed from the Berg and Kempton (1988) stack-unit map data and adapted in this study to delineate permeable glacial deposits that have a thickness of 20 ft or greater (continuous or non-continuous) within 50 ft of land surface. In Cook County, the resulting area includes large sections along major streams and areas along the Lake Michigan shoreline. These areas of permeable glacial deposits, 20-ft thick or greater and within 50 ft of land surface, are shown in figure 2.

The shallow glacial deposits indicated by the stack-unit map to have aquifer potential comprise the Equality Formation, Henry Formation, Cahokia Alluvium, Peoria and Roxana Loess, Wedron Formation, Grayslake Peat, and Parkland Sand. All of these areas are included for potential stormwater-infiltration location, but it is noted that the Wedron Formation, listed as "silty or clayey" in the stack-unit description, and the Grayslake Peat, a result of filling of water bodies and wetland areas, likely have lower hydraulic conductivities than are desirable for induced infiltration (fig. 3).

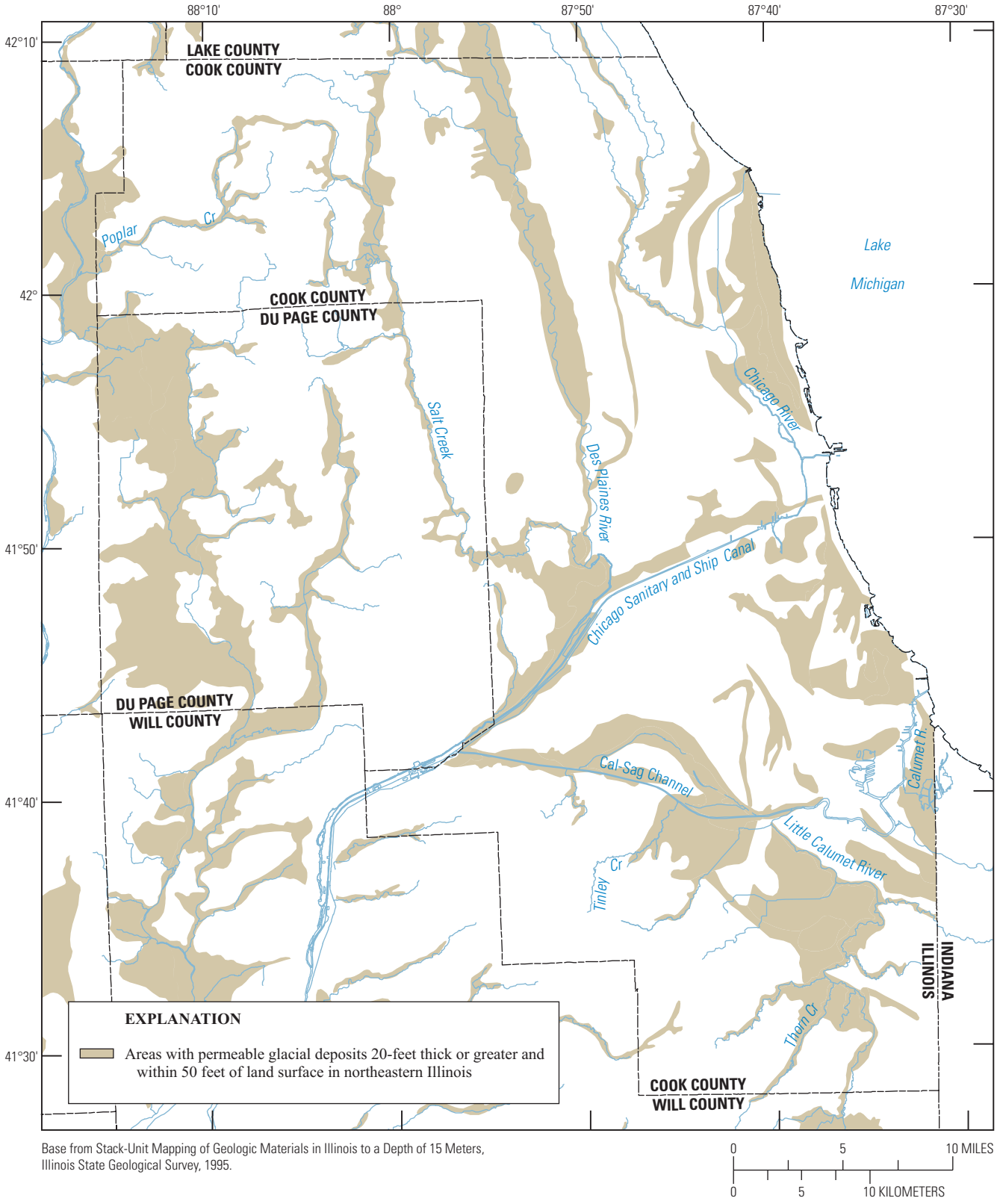

Figure 2. Areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface, in northeastern Illinois.

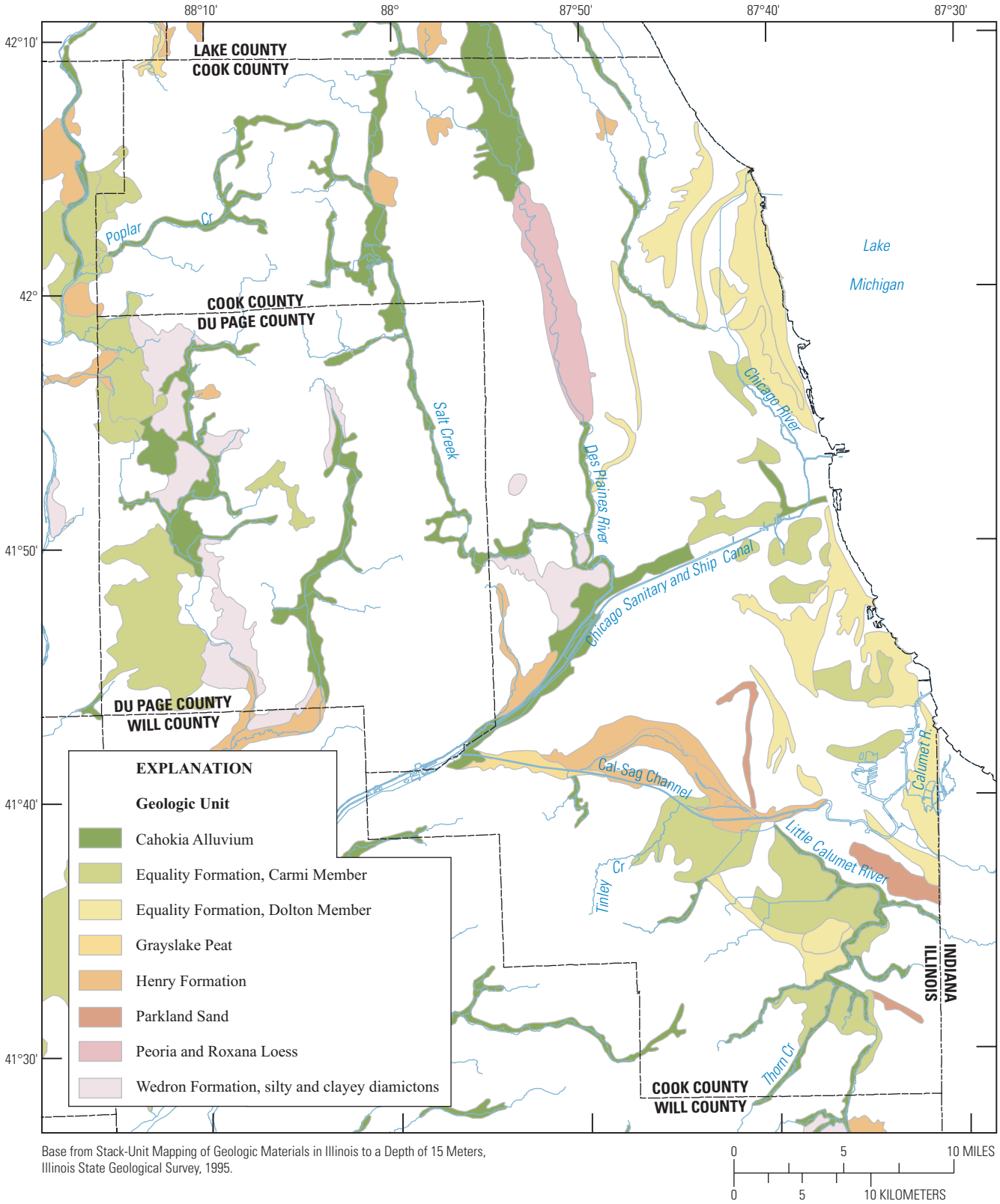

Figure 3. Surficial geologic units overlying areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface, in northeastern Illinois.

Bedrock

Bedrock that is fractured may develop preferential flow paths, which would not allow sufficient filtering and attenuation of contaminants to improve water quality and could lead to contamination of the groundwater system. Bedrock that is not fractured generally will impede infiltration. For purposes of this report, the presence or lack of unconsolidated deposits, interpreted from the mapping of underlying geology, is used to determine if near-surface bedrock is of concern. By designating the initial condition of permeable glacial-aquifer deposits being at least 20-ft thick, bedrock is thereby assumed to be at least 20 ft or more below ground surface.

Wetlands and Depth to Saturated Zone

The National Wetlands Inventory (NWI) designated wetland areas where water saturation determines soil development and the animal and plant communities, and the soil is at least periodically saturated. Categories in the NWI include bottom-land forest, deep marsh, deepwater lake, and shallow marsh/wet meadows. Regulatory restrictions and consistent saturation of land areas identified in the NWI eliminate these areas from consideration as potential induced-infiltration areas. These wetland areas were superimposed on the initial map produced based on underlying geology. The NWI areas located in areas of potential glacial-aquifer deposits 20-ft thick or greater are shown in figure 4.

The depth to the saturated zone (water table) is important for several reasons. A buffer [temporary storage] zone of unsaturated deposits is needed to allow possible mounding of groundwater from infiltration, as well as insuring that there is a filtration zone to remove sediment and some contaminants from stormwater before it enters the groundwater system. Siltation and clogging of the initial contact layer by sediment and other solids in stormwater and (or) biological growth above the water table will occur, and maintenance and cleaning of this layer will be necessary (U.S. Environmental Protection Agency, 2000). McHenry and DuPage County regulations recommend an unsaturated zone depth of greater than 3 to 4 ft. The unsaturated zone thickness of 4 ft was chosen for the Cook County area to be consistent with these nearby counties.

Estimating depth to water table in Cook County is complex. Water-table conditions vary seasonally by several feet, and some areas that have widely fluctuating water tables may not be suitable during certain times of the year, particularly areas near streams that may be affected by stream bank storage. Currently (2009), there are not enough water-table wells or water-table elevation data to accurately determine the water-table altitude for the Cook County area. The population in Cook County uses Lake Michigan as the primary source of drinking water, and this use expanded into portions of DuPage, Will, and Lake Counties in the latter part of the 20th century. As a result, few wells are available in the area for use in measuring the depth to water table. For example, water levels were published in Russell (1963) for Cook County only in bedrock wells; no wells in unconsolidated deposits were included. The Illinois State Water Survey (ISWS) monitors approximately 35 shallow groundwater wells in the Illinois Climate Network (ICN) and Water and Atmospheric Resources Monitoring (WARM) Programs, but none of the wells are in Cook County. No wells were found in the online ISWS Private Well Database that were listed as being in an unconsolidated aquifer and having water-table conditions. The Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) project for Cook County, which will provide an estimate of depth to water for the Cook County area, is scheduled to be completed in 2011 (Robert McLeese, U.S. Department of Agriculture, personal commun., 2008; Dale Calsyn, U.S. Department of Agriculture, personal commun., 2008) and currently (2009), water-level data are not available. These data, when published, may be useful in further refining areas for potential induced infiltration. The available NRCS State Soil Survey Geographic Database (STATSGO) data are not sufficiently detailed for site-specific application. The data are included here only to show that water-table levels are expected to be shallow and near surface throughout the study area, generally within 0 to 3 ft below ground surface. The data also indicate that the areas with the shallowest water-table depths are in southern Cook County, and the deeper water-table depths are near the Des Plaines River and the Chicago Sanitary and Ship Canal (fig. 5).

The depth to saturated zone was estimated using stream and pond water-surface elevations, which are assumed to represent adjacent subsurface water-table conditions. The USGS National Water Information System (NWIS) well database includes 45 wells in Cook County constructed in glacial aquifers that may indicate water-table conditions. The Illinois State Geological Survey (ISGS) well database includes 115 highway and engineering borings including water-level measurements that indicate water-table conditions. All of these presumed water-table measurements were taken at different times during the year and thus may not be representative of average conditions. These groundwater data and elevation points for streams and ponds (determined from the 10-m National Elevation Dataset (NED)) were combined and interpolated using kriging methods to develop a continuous water-table surface. This water-table surface was then subtracted from land-surface elevation to provide an estimated depth-to-water zone (fig. 6).

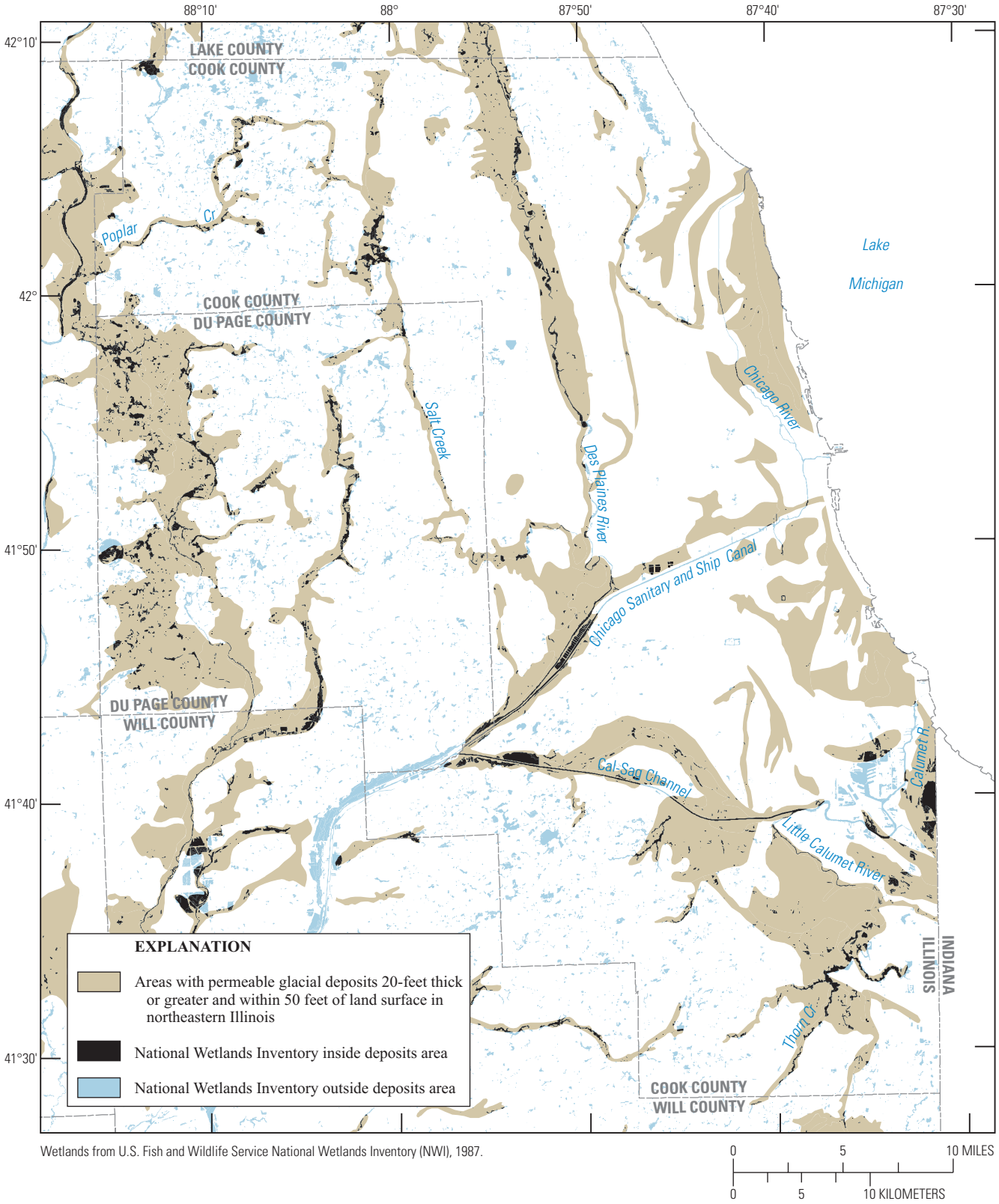

Figure 4. Wetland areas located within areas of permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface, Cook County, northeastern Illinois.

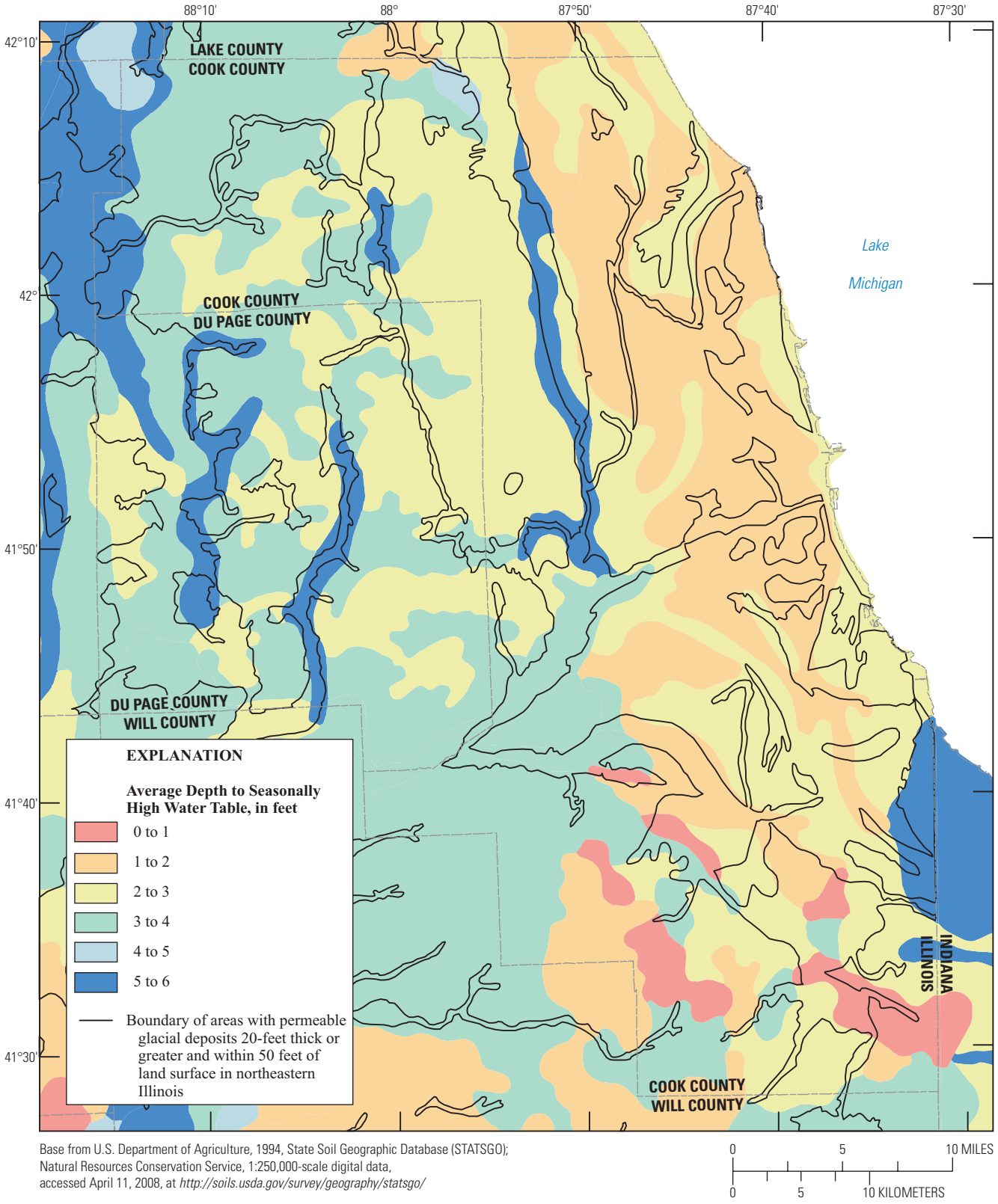

Figure 5. Average depth to seasonally high water table from the 1994 State Soil Geographic Database (STATSGO), northeastern Illinois.

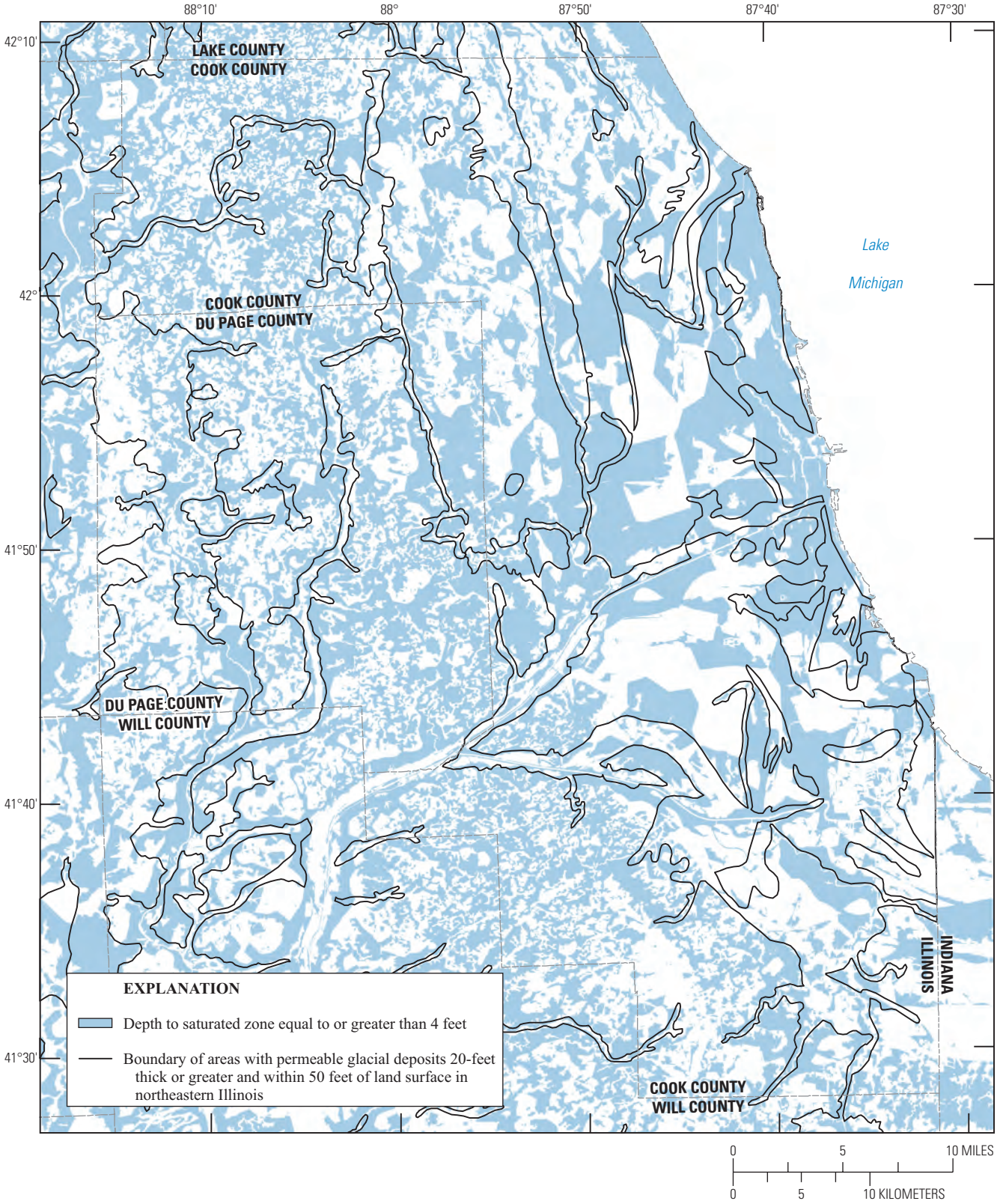

Figure 6. Areas where estimated depth to saturated zone is 4 feet or greater, northeastern Illinois.

Distance from Streams

Areas surrounding streams may have fluctuating groundwater levels from changing river levels resulting in bank-storage effects. At potential passive induced-infiltration-structure locations near streams, stream stage and groundwater-level monitoring for temporal variation during storms to determine the range of water-level fluctuation and estimating peak elevations and durations would be a component of a detailed assessment of site suitability.

In some areas in close proximity to streams and consisting of high-permeability deposits, the residence time of infiltrated water could be short because of the short distance of the stream to the passive induced-infiltration structure. Rather than long-term groundwater storage resulting from construction of a passive induced-infiltration structure in these areas, a time-delayed release of filtered stormwater into the stream may better describe the flow pattern. Depending upon the length of the delay, this may produce the desired effects of reduced stormflow peaks and decreased combined sewer flows, but would not produce substantial long-term groundwater recharge. Water-quality improvements may not be substantial, but are expected to improve relative to direct stormwater runoff.

Land Cover and Use Characteristics

Land use and cover, specifically anthropogenic, can affect the hydrologic characteristics of infiltration basins as well as the legal and political encumbrances associated with a particular land parcel. The land cover in Cook County is approximately 75 percent low- to high-density developed land. Medium- to high-density developed land (50 to 100 percent impervious cover) is approximately 39 percent. The remaining 25 percent is primarily forest (9 percent) and open space (9 percent) (U.S. Department of Agriculture, 2007). Most of Cook County is urbanized and has a large proportion of impermeable area including roads, parking lots, and buildings. As a result, passive induced-infiltration structures likely will be on land without infrastructure and small because of space availability.

Cook County Forest Preserves are relatively large areas of open space land cover and , thus, are possible areas to consider in initial assessments of potential areas for infiltration. MWRDGC land holdings also are possible areas to consider for siting passive induced-infiltration structures. Cook County Forest Preserve areas and MWRDGC land holdings are designated in figure 7.

Buildings with Basements

Buildings with basements, as designated in the 2006 Cook County Assessor data (digital data obtained through MWRDGC), are useful in evaluating location suitability for a passive induced-infiltration structure. It is reasonable to assume that if a building has a basement, the water table generally is deeper than 4 feet. Areas having residential or commercial buildings with basements can strengthen the indication that potential areas are suitable for passive induced-infiltration structures or can indicate that further investigation of hydrologic conditions is needed. Conversely, if a passive induced-infiltration structure is constructed near buildings with basements, raised groundwater levels may cause leakage problems in these buildings or increase existing problems. The location of buildings with basements in relation to potential recharge areas is shown for informational purposes in figure 8.

Sewer Systems/Drainage Tiles

Areas suitable for stormwater infiltration preferably would have up-to-date mapped locations of sewer lines and (or) tunnels. Newer sewer lines are grouted and less prone to leakage; however, older sewer lines are prone to leakage, both into and out of the sewer pipes, and may have considerable interaction with the subsurface water adjacent to the sewer line. Extensive interaction among passive induced-infiltration structures and sewer lines may reduce the effectiveness of decreasing stormwater runoff. Sewer-line locations and depths would be too numerous and complex to plot on maps presented in this report; locating these features would be a component of a detailed assessment of site suitability.

Parts of Cook County still may have drainage tiles present from when the land was farmed. Any drain tiles found in the subsurface likely will be collapsed, clogged, or intercepted and terminated as a result of urban development. If drain tiles are found during infiltration-structure construction, further hydrologic investigation may be necessary to determine their status.

Supply Wells

Proximity of supply wells to induced infiltration areas is a concern. McHenry County regulations specify that infiltration-basin systems should be at least 200 ft from supply wells. Cook County uses Lake Michigan for a drinking-water source; however, there are water-supply wells in Cook County according to the Illinois State Geological Survey online well database, ILWATER, available at *http://www.isgs.illinois.edu/maps-data-pub/wwdb/launchims.shtml*. Many of these wells likely are not being used or are for non-potable use. Verifying well location, depth to producing zone, and status relative to a possible passive induced-infiltration structure would be a component of a detailed assessment of site suitability.

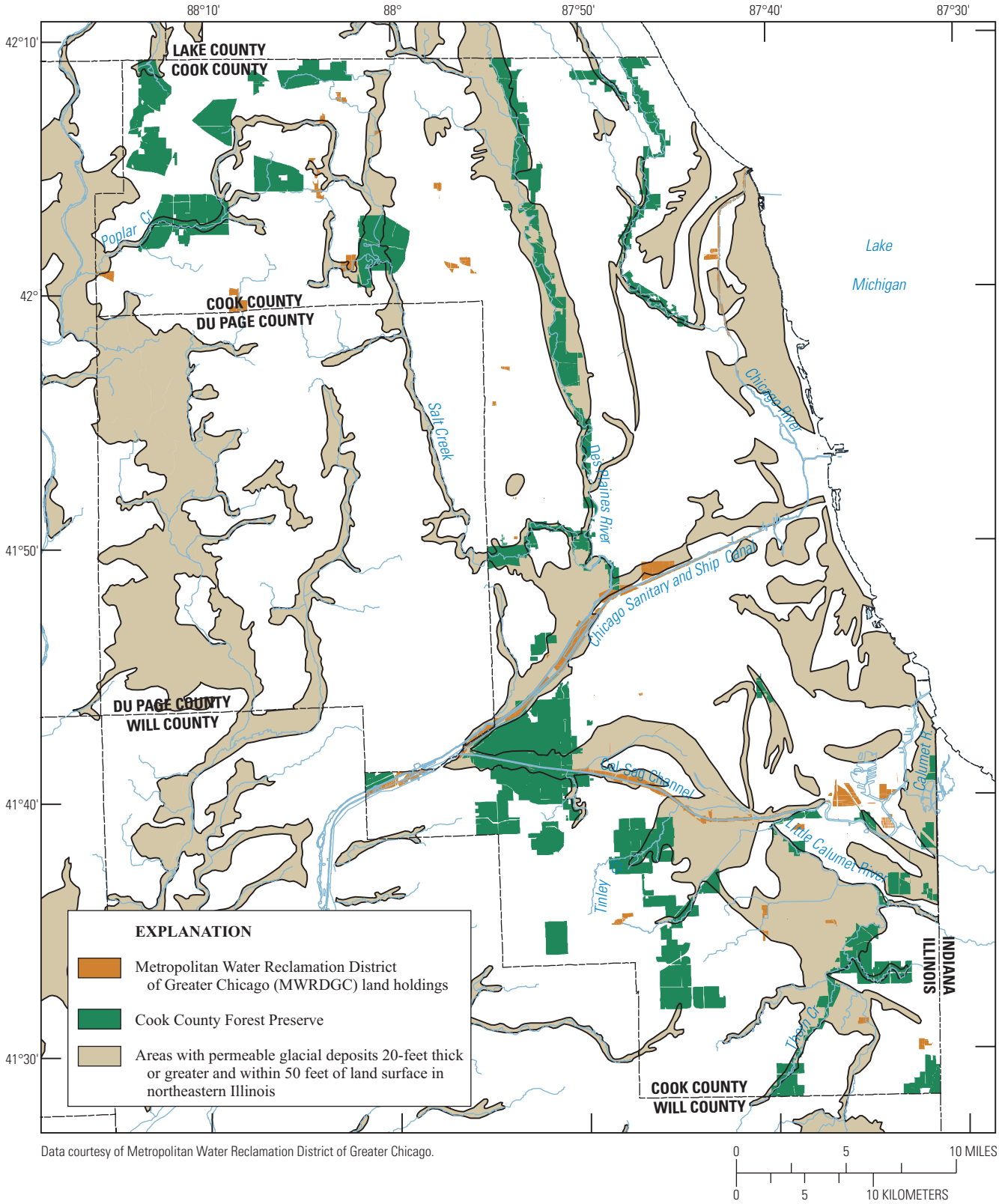

Figure 7. Land holdings of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) and Cook County Forest Preserve areas, Cook County, northeastern Illinois.

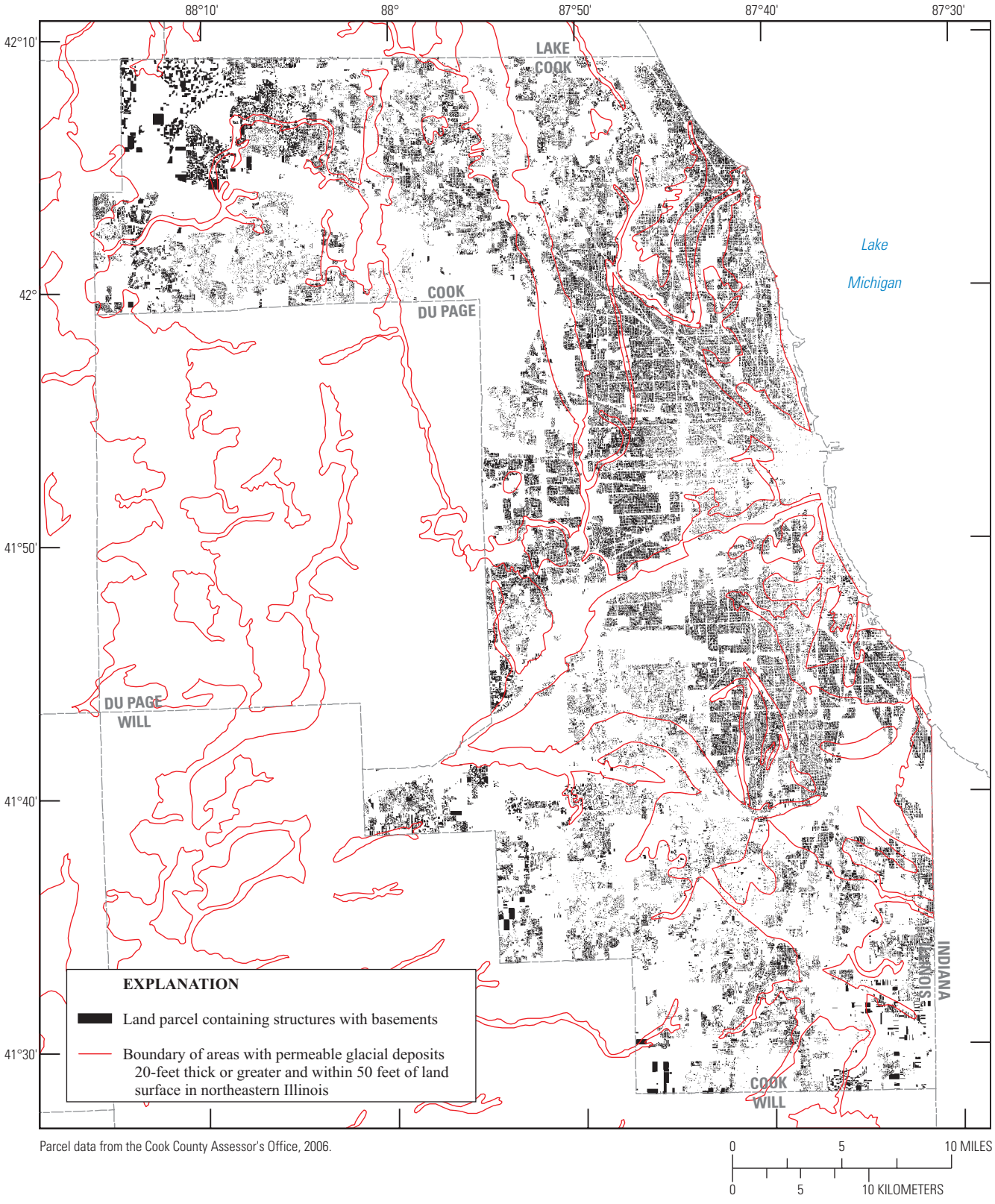

Figure 8. Land parcels containing structures with basements, Cook County, northeastern Illinois.

Dewatering Activities

Active and inactive quarries that are located near passive induced-infiltration structures can have substantial effects on hydrology. Pumping to dewater quarries could draw water through near-surface deposits toward the quarry. Infiltrated stormwater drawn to the pump may require treatment before it is disposed if it does not meet National Pollutant Discharge Elimination System (NPDES) standards, because of the short residence time in the ground.

In abandoned or unused quarries where pumping has been discontinued, water has likely filled the quarry to a stable level. Groundwater levels surrounding the quarry will reflect the quarry water level. The area surrounding the quarry may have water-table levels that make the surrounding area unsuitable for stormwater infiltration.

Quarries are shown in figure 9. The major bedrock quarries are McCook, Thornton, and Lyons. Sand-and-gravel producing quarries (pits) are located in the northwest. Local investigations of operation status, water levels, and depth to bedrock would be a component of a detailed site assessment before a passive induced-infiltration structure was constructed.

Legacy Contamination

Areas with documented contamination were designated not suitable for passive induced-infiltration structures because of the risk of off-site transport of contamination. Leaking Underground Storage Tank (LUST) sites are exceptionally numerous and are point locations only whereas the other three other types of legacy contamination are areal data. As a result, LUST sites are described and mapped separately in the following discussion of methods.

Superfund Sites, Resource Conservation and Recovery Act (RCRA) Facilities, and Brownfields

Superfund sites are abandoned areas where sufficient hazardous substance is present for the USEPA to declare the area as unusable until cleaned up to designated standards under the Comprehensive Environmental Response, Contamination and Liability Act (CERCLA). Superfund sites listed are not on the National Priority List. Resource Conservation and Recovery Act (RCRA) facilities are designated by the USEPA as active treatment, storage, or disposal sites that handle physical, chemical, and biological waste. Brownfield sites are former industrial- or commercial-land areas that have lower levels of contamination, allowing reuse of the land once cleanup or development restrictions are in place. Brownfield sites are listed as not suitable, but may be suitable in the appropriate setting, dependent upon the severity of contamination and surrounding land use.

These sites were located by using USEPA and IEPA databases. The address of the land owner in the databases was linked to the parcel of land at that address. Multiple parcels of land may be owned by one business; therefore, the acres of land determined not suitable may be substantially underestimated. Brownfield-site boundaries and acreage are not well defined (Illinois Environmental Protection Agency, 2009a); therefore, total acreage of Brownfield sites is likely underestimated. The resulting land area for Superfund sites, RCRA facilities, and Brownfield sites is shown in figure 10.

Leaking Underground Storage Tanks

Leaking Underground Storage Tank (LUST) sites are where tanks have previously leaked fuel or other toxic substances. While many of these sites may have been remediated to USEPA standards, continued cleanup and monitoring of many of these sites may be ongoing. Presently (2009), there are 6,079 LUST sites in Cook County (Illinois Environmental Protection Agency, 2009b) (fig. 11). LUST sites will have had previous groundwater investigations including information on water levels and direction of groundwater flow at the site. The 2009 data are for individual sites and were not available as a combined data set that could be used to determine groundwater geology and levels on a countywide basis. These groundwater investigations will be useful at a localized level in determining if hydrogeologic conditions are appropriate for a passive induced-infiltration structure to be located upgradient or at a sufficient distance away from the LUST site.

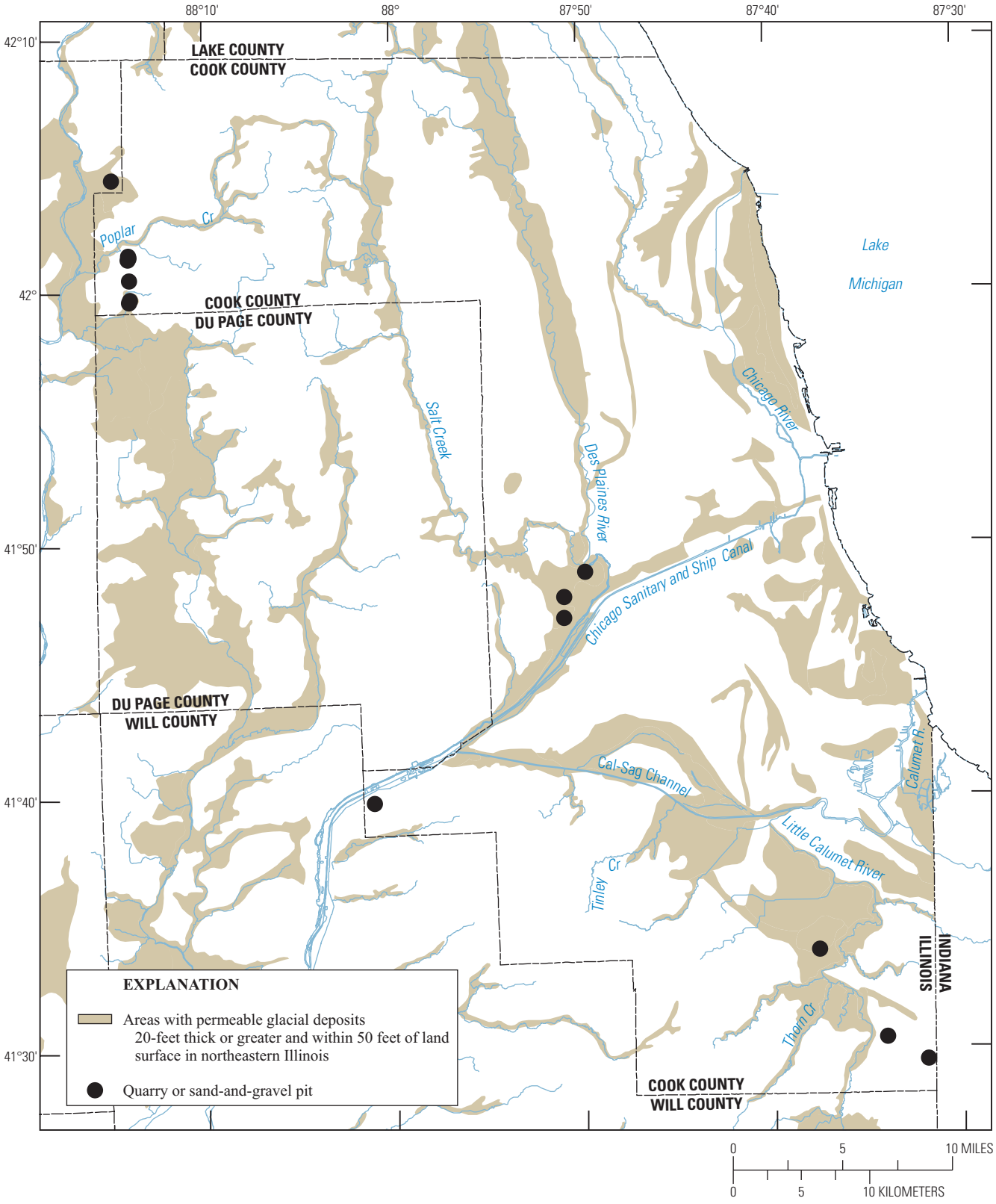

Figure 9. Locations of quarries and sand-and-gravel pits in Cook County, northeastern Illinois.

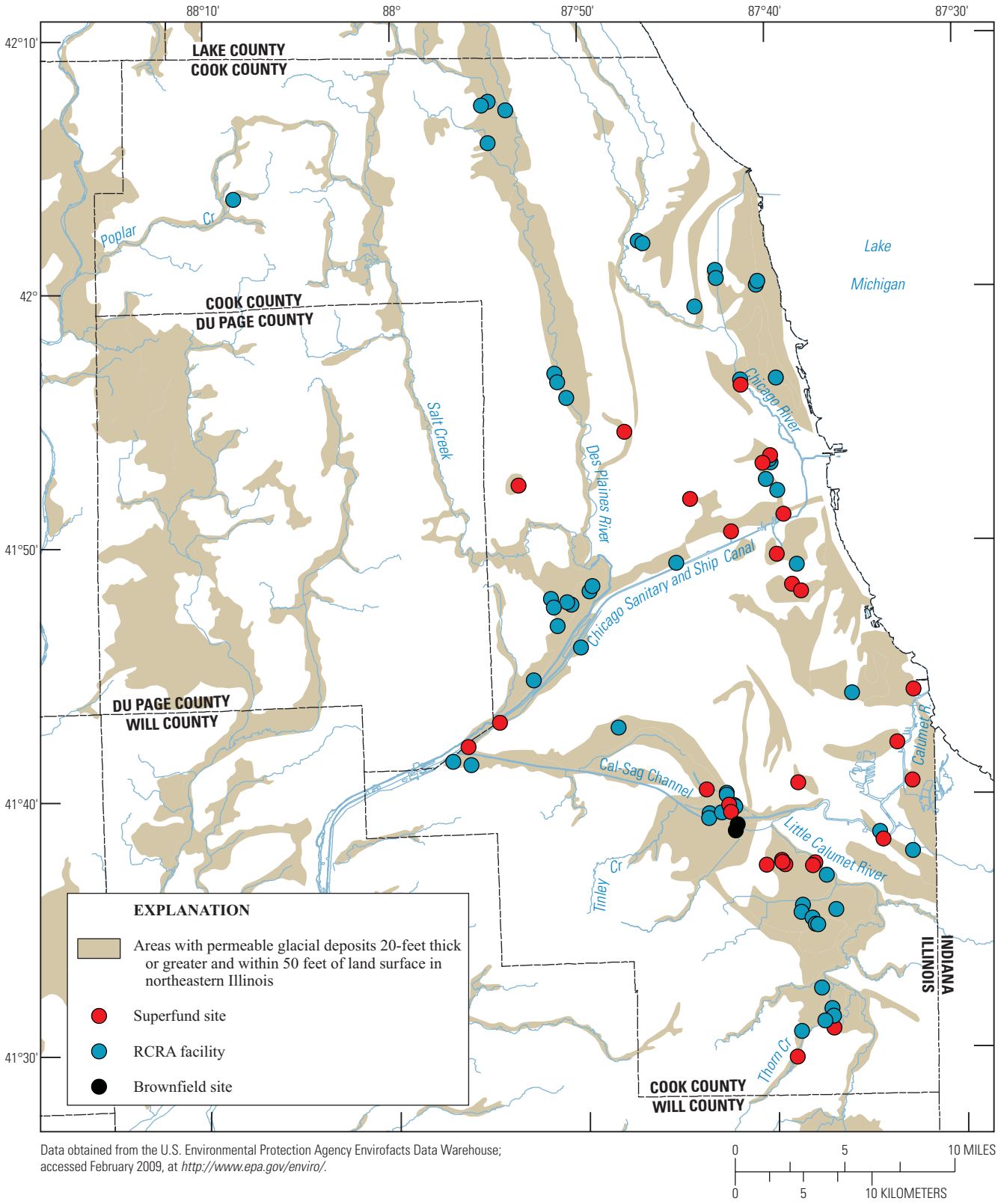

Figure 10. Locations of U.S. Environmental Protection Agency Superfund sites, Resource Conservation and Recovery Act (RCRA) facilities, and Brownfield sites, Cook County, northeastern Illinois

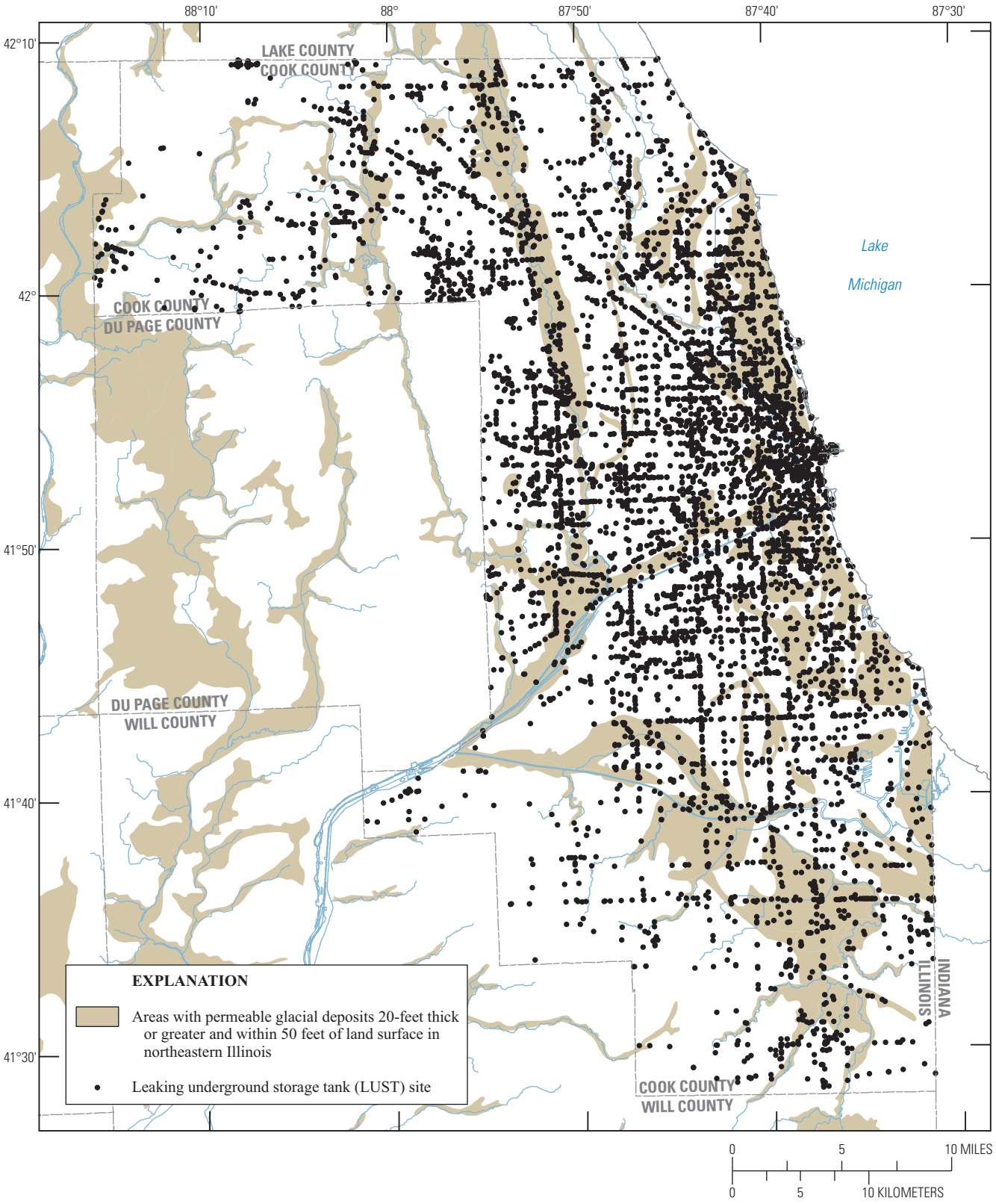

Figure 11. Locations of U.S. Environmental Protection Agency leaking underground storage tanks (LUST) in Cook County, northeastern Illinois.

Preliminary Assessment of Infiltration Potential

Cook County is approximately 612,636 acres of mostly medium to high-density urban land. Results of overlaying and evaluating hydrogeologic and land cover and use characteristics for preliminary assessment of areas suitable for a passive induced-infiltration structure are presented herein as a series of maps.

Mapping Characteristics to Prioritize Areas for Assessment

The initial consideration for determining potential areas for passive induced-infiltration structures is the underlying permeable geology. Glacial-aquifer deposits that are 20 ft or more in thickness, but not necessarily continuous, within the first 50 ft below land surface were delineated based on data from Riggs and others (1997). These initial areas comprise 153,992 acres (approximately 25.1 percent of the county) and largely consist of land along the major streams in Cook County, along with areas bordering Lake Michigan and in southern Cook County (fig. 2).

The NWI areas within the above-delineated areas were removed from consideration. A total of 9,756 NWI acres were deleted, leaving 144,237 acres or approximately 23.5 percent of Cook County (fig. 12).

Superfund sites; Brownfield sites; and RCRA treatment, storage, and disposal facilities were then removed from the remaining potential area. There are 855 acres of RCRA facilities, 669 acres of Superfund sites, and 0.6 acres of Brownfield sites present for a total of 1,525 acres deleted, leaving 142,712 acres or approximately 23.3 percent of Cook County. The Brownfield site acreage may have potential for induced infiltration (fig. 13). The Brownfield site acreage likely is substantially underestimated because of insufficient database input, contamination sites being assigned to the designated parcel of land at the site address, and possible database status as a CERCLA (Superfund) site.

Areas that may have less than 4 ft of depth to the water table were removed from the remaining potential area. A total of 66,632 acres were removed in this step, leaving 76,080 acres or approximately 12.4 percent of Cook County. These remaining areas have the greatest potential for induced infiltration in Cook County (fig. 14).

Of the 76,080 acres of land with potential for induced infiltration, 4,390 acres are located where the poorly permeable “silty or clayey” Wedron Formation or Grayslake Peat may be present in sufficient thickness to limit infiltration. Of these 4,390 acres, 3,289 acres include the Wedron Formation and 1,101 acres include the Grayslake Peat. Although these areas are listed as coarse deposits by Riggs and others (1997), site-specific confirmation of geologic units and thickness is needed in these areas to confirm sufficient permeability (fig. 15).

Currently (2009), there are 9,825 acres of land held either by the MWRDGC (1,458 acres) or the Cook County Forest Preserve (8,367 acres) in potential infiltration areas. These areas are shown in figure 16.

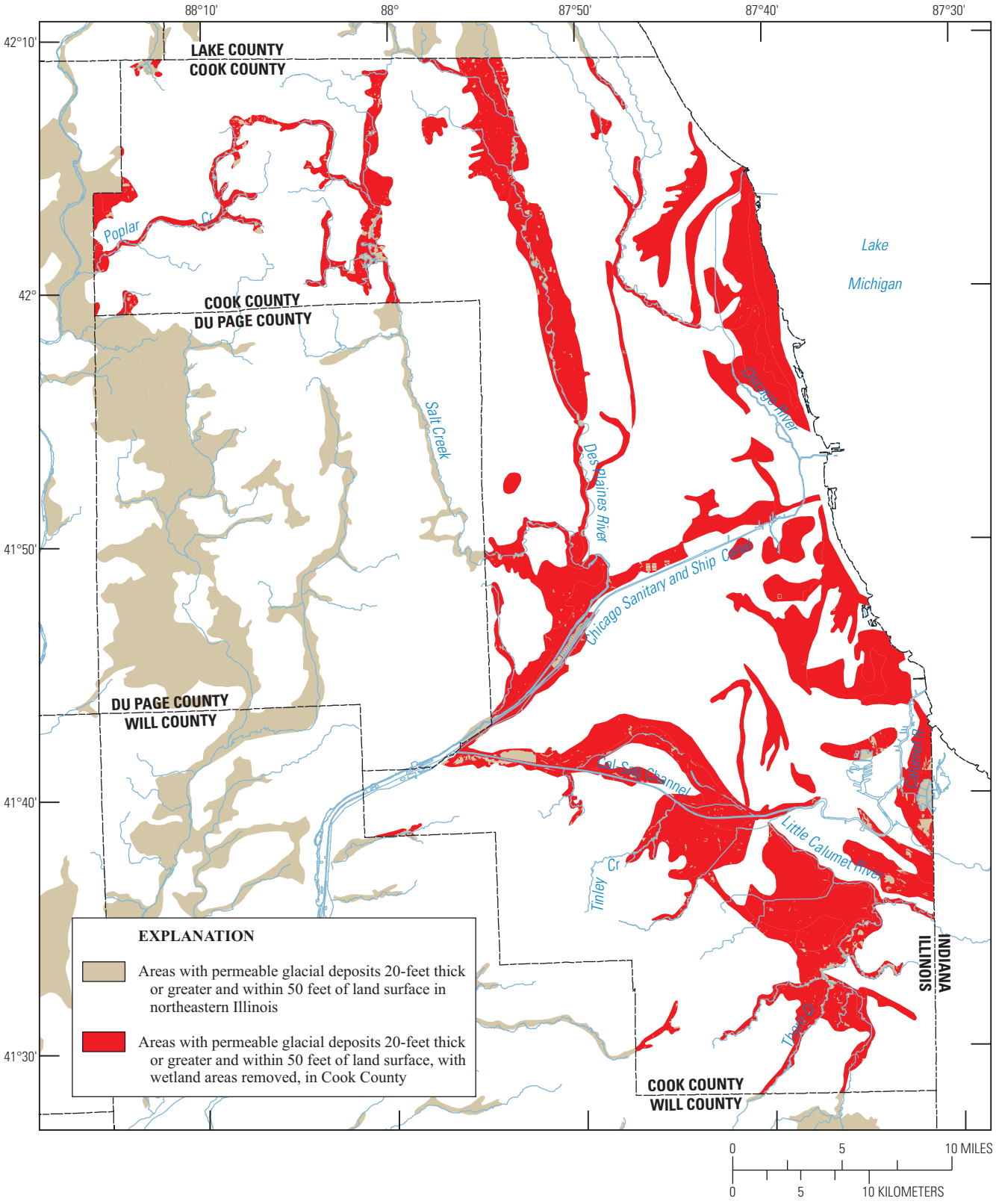

Figure 12. Areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface but with wetland areas removed, Cook County, northeastern Illinois.

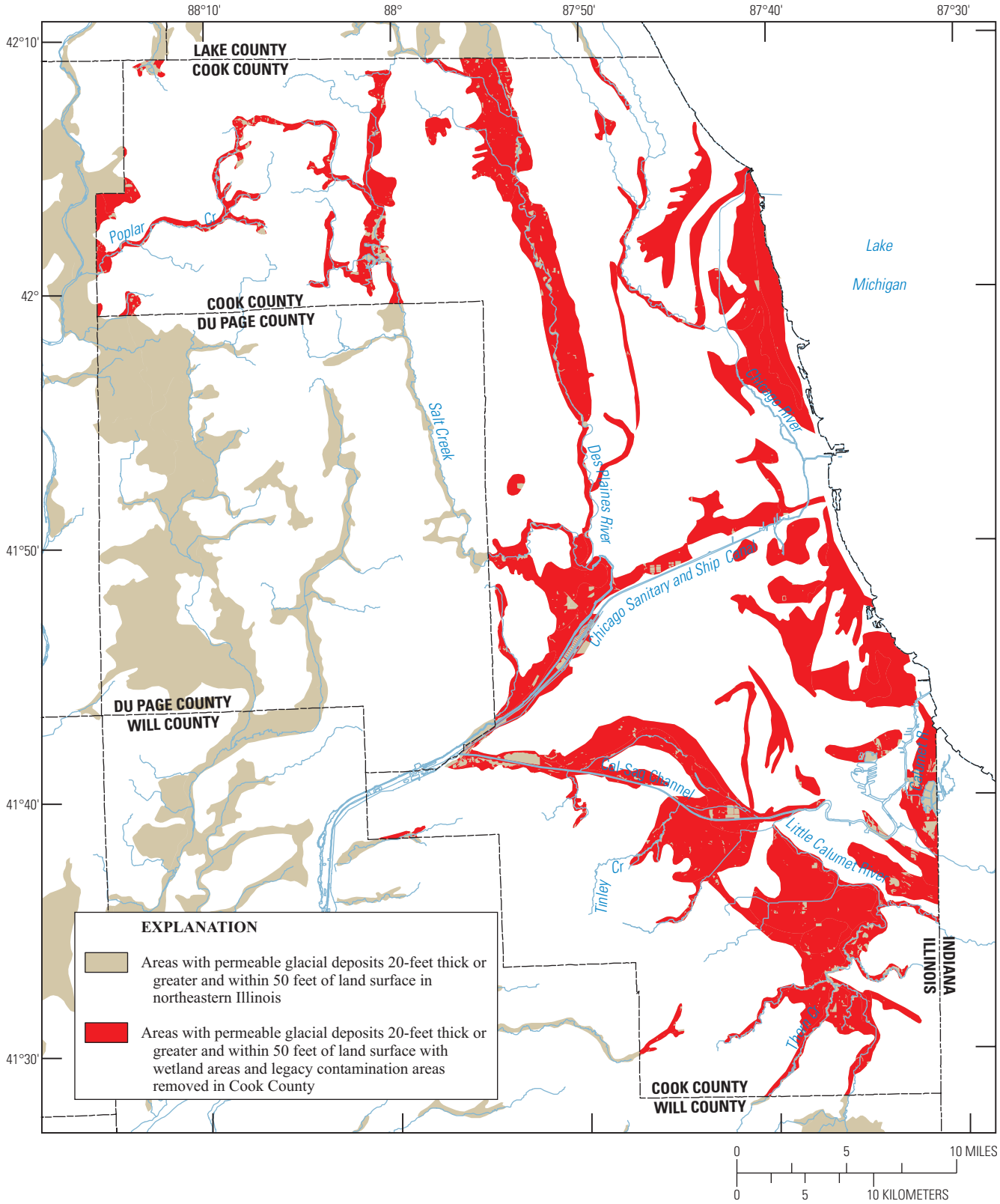

Figure 13. Areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface after removal of wetland areas and legacy contamination areas (except LUST sites), Cook County, northeastern Illinois.

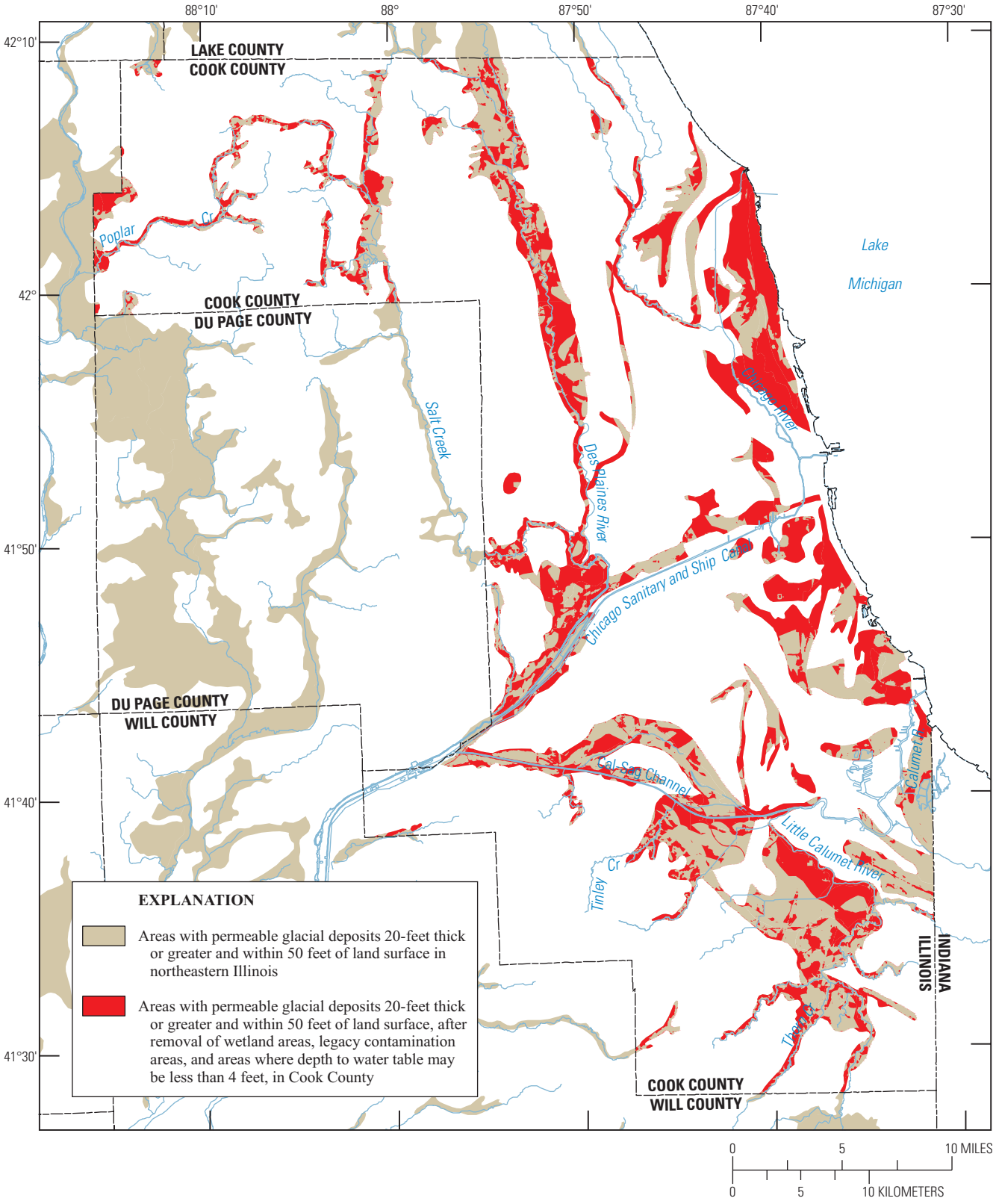

Figure 14. Areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface after removal of wetland areas, legacy contamination areas (except LUST sites), and areas where depth to water table may be less than 4 feet, Cook County, northeastern Illinois.

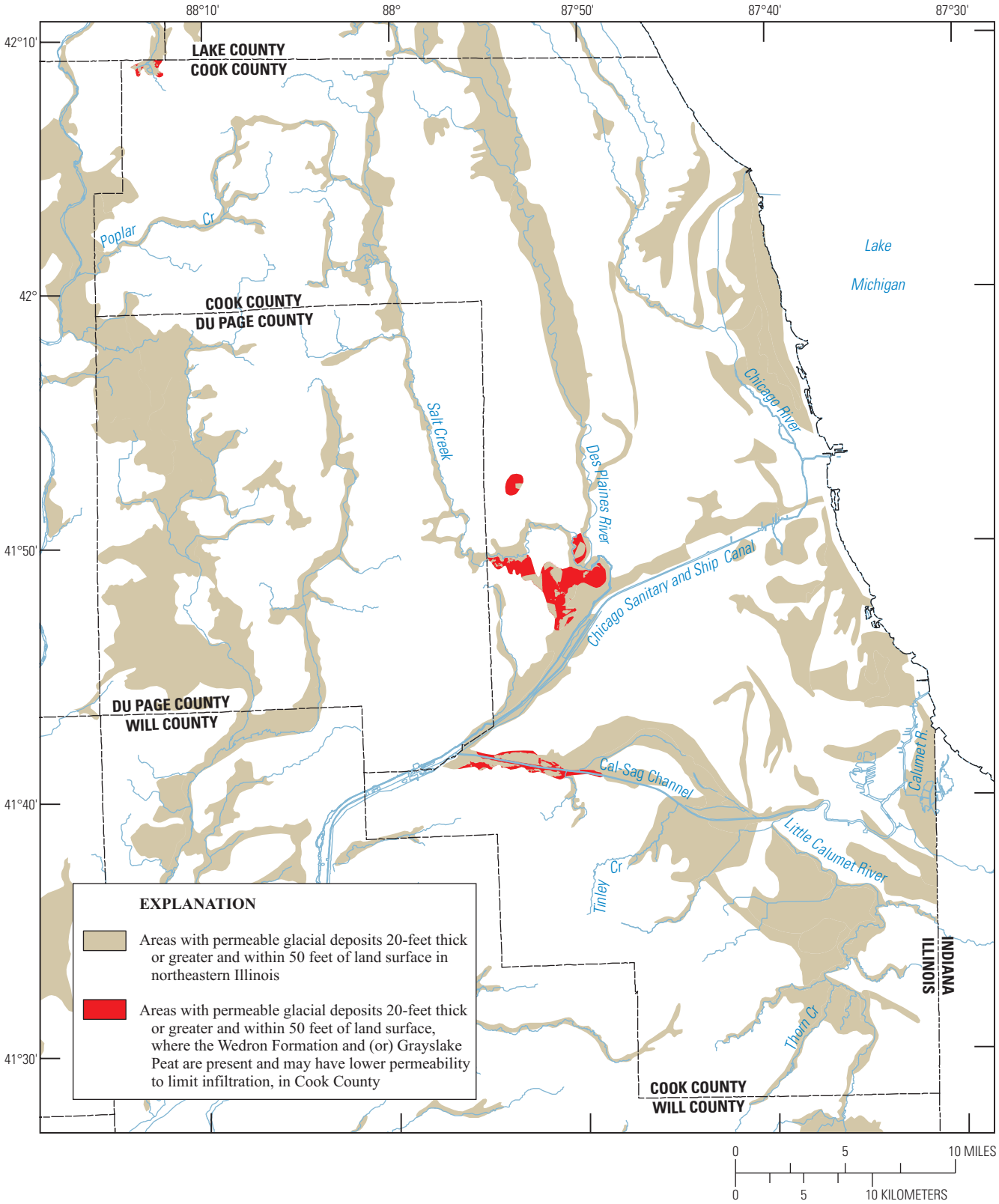

Figure 15. Areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface and where the Wedron Formation and (or) Grayslake Peat are present, Cook County, northeastern Illinois.

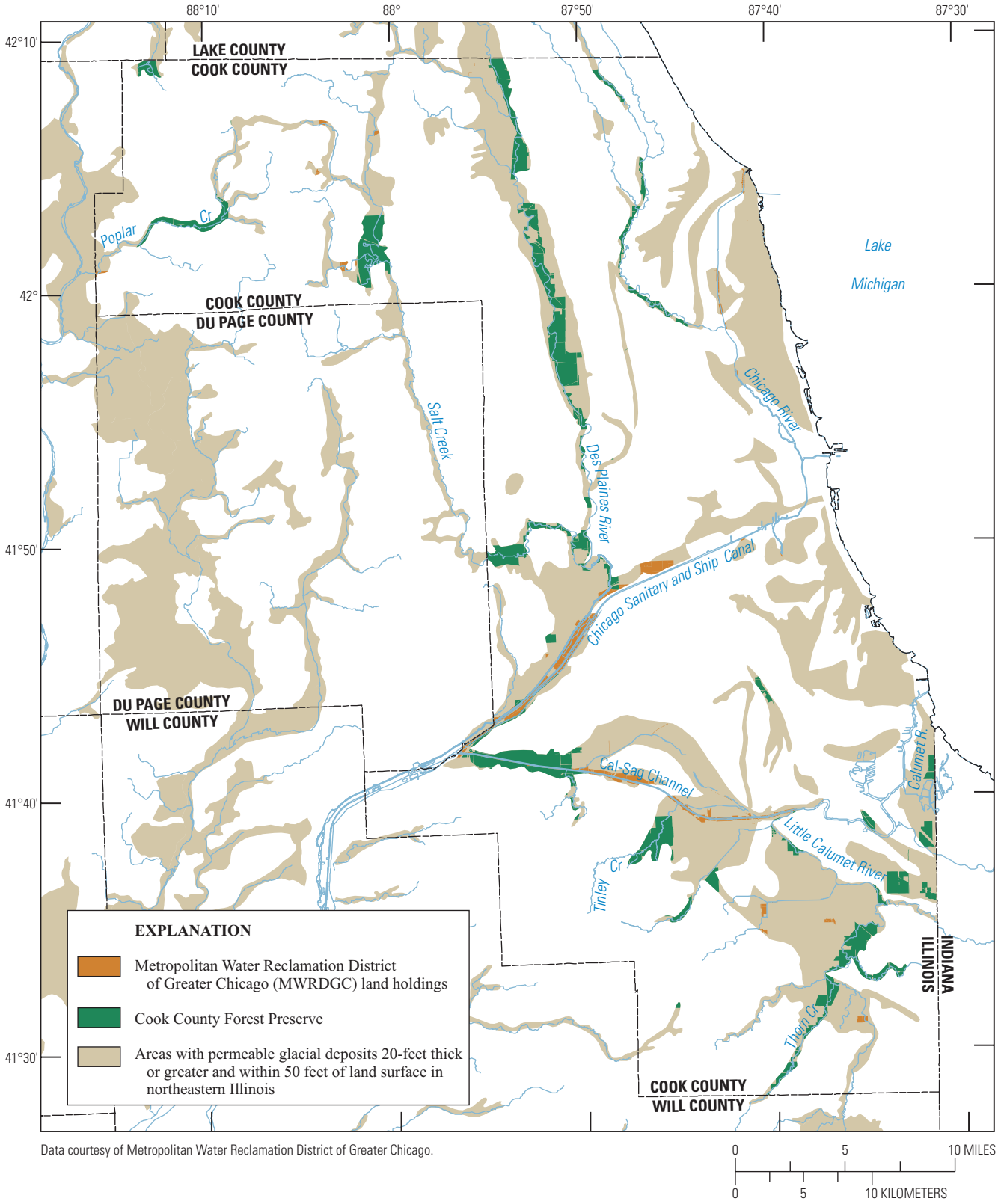

Figure 16. Land holdings of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) and Cook County Forest Preserve located within areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface, Cook County, northeastern Illinois.

Groundwater Flow to Lake Michigan

Of the 76,080 acres that have potential for infiltration of stormwater, 8,650 acres (11.4 percent) are within the Lake Michigan surface watershed (fig. 17), with the remaining 67,430 acres within the Illinois River surface watershed. Within the Lake Michigan surface watershed, water naturally would flow overland to Lake Michigan; however, storm-sewer drains in the basin divert almost all the surface runoff away from Lake Michigan and into the Chicago Waterway system or treatment facilities discharging to the Illinois River Basin. If it is assumed that the groundwater level mimics topography, then the water infiltrated into the Lake Michigan surface watershed likely flows toward Lake Michigan. Without a network of water-table observation wells, it is not possible to precisely determine whether the groundwater divide coincides with the surface-drainage divide, or if the groundwater divide is affected by groundwater withdrawals or anthropogenic changes in surface topography and drainage that may alter which areas that may contribute groundwater flow to Lake Michigan.

These 8,650 acres are approximately 1.4 percent of the 612,636 acres in Cook County. The total possible stormwater infiltration in these 8,650 acres that could pass through the subsurface to Lake Michigan would be approximately 1,036,000,000 ft^3, if all the yearly average rainfall (33 in.) that falls on this watershed area were collected, stored, and allowed to infiltrate. For comparative purposes, this is approximately equivalent to a flow of about 33 ft^3/s throughout the year. The potential for an appreciable groundwater contribution to Lake Michigan from induced infiltration within the surface-watershed area is small, about 1 percent, in comparison to the amount being withdrawn by Illinois (approximately 3,200 ft^3/s) from Lake Michigan. However, this amount may be appreciable in comparison to the additional potable water supply available to Illinois communities. Other factors affecting the actual groundwater flow to Lake Michigan would be the amount of land available for potential infiltration and the land area being drained to the passive induced-infiltration structure.

Summary

Areas for potential induced infiltration of stormwater runoff in Cook County, Illinois, were delineated based on hydrogeologic and land cover and use characteristics. Coarse-grained deposits 20-feet thick or greater within 50 feet of land surface were initially delineated in Cook County for the base map; this also eliminated areas where bedrock was within 20 feet of ground surface. Wetlands, as delineated in the National Wetlands Inventory, along with unsaturated deposits thinner than 4 feet estimated based on available groundwater levels, elevations of surface-water bodies, and land-surface topography, using Geographic Information System methods also were then eliminated from consideration. Superfund–Resource Conservation and Recovery Act facilities and Brownfield locations also were removed from consideration.

A total of 76,080 acres of the 612,636 acres of land in Cook County were determined to have the highest potential for induced stormwater infiltration. Most of these areas are along selected stream reaches, notably the Des Plaines River, Little Calumet River, Midlothian Creek, Salt Creek, Poplar Creek, Thorn Creek, Tinley Creek, the Sanitary and Ship Canal, and the Calumet Sag Channel. The proximity to streams is owing to the presence of alluvium and the associated, generally greater, hydraulic conductivity in those areas. There are 1,458 acres of MWRDGC holdings and 8,367 acres in the Cook County Forest Preserve. There also are substantial areas for potential induced infiltration bordering Lake Michigan and in southern Cook County.

Within the Lake Michigan surface-water drainage basin, 8,650 acres of land potentially are suitable for induced stormwater infiltration. The amount of groundwater flow to Lake Michigan, if all rain falling on this area was infiltrated, would be about 33 cubic feet per second on a yearly average basis. However, a more thorough investigation of the groundwater divide and flow of shallow groundwater toward the Lake, including possible sewer-pipe complications near passive induced-infiltration structures and the Lake, may be needed to make a better determination of the potential contribution of enhanced infiltration to Lake Michigan.

General areas potentially suitable for induced stormwater infiltration have been delineated for the entire Cook County area. This assessment is preliminary because the scale of the mapping only gives a general indication of potential infiltration areas and is not suitable for site-specific investigations. Field confirmation of a) the hydrogeology including nature of subsurface deposits, wetland areas, stream interactions, and depth to saturation, b) the orientation of sewer systems and drainage tiles, c) other infrastructure such as buildings with basements, supply wells, dewatering activities, and d) the nature of legacy contamination would be components of a detailed assessment of site suitability.

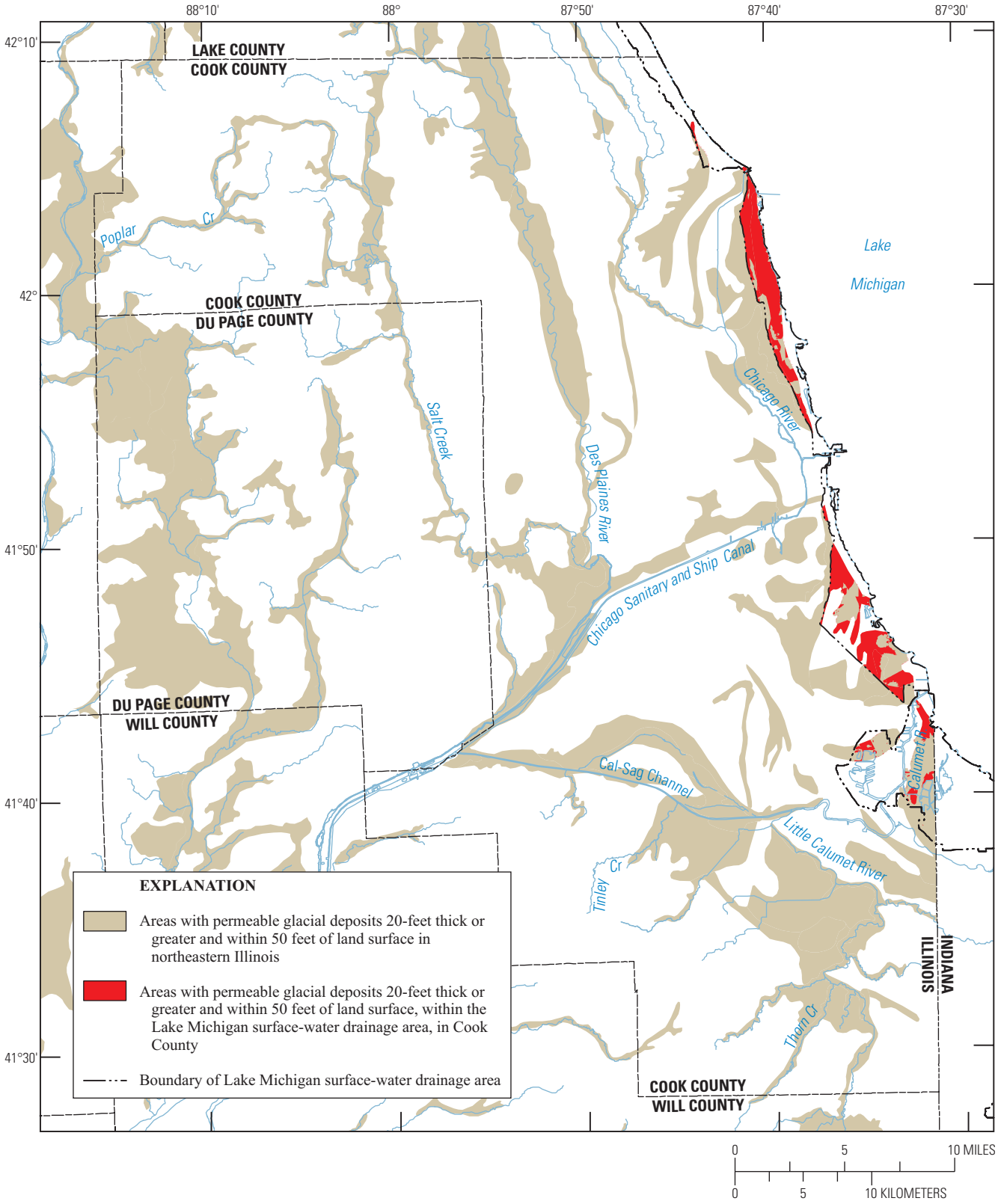

Figure 17. Areas with permeable glacial deposits 20-feet thick or greater and within 50 feet of land surface within the Lake Michigan surface watershed, Cook County, northeastern Illinois.

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